AFLONEXT FINAL CONFERENCE

Noise Control on Flap Side Edge

AFLoNext

2ND GENERATION ACTIVE WING

ILA Berlin 2018

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- Wind Tunnel Test
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- Flight Test
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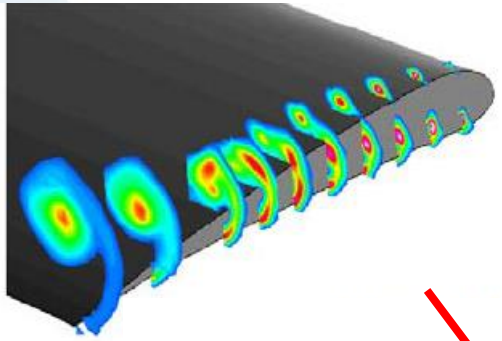
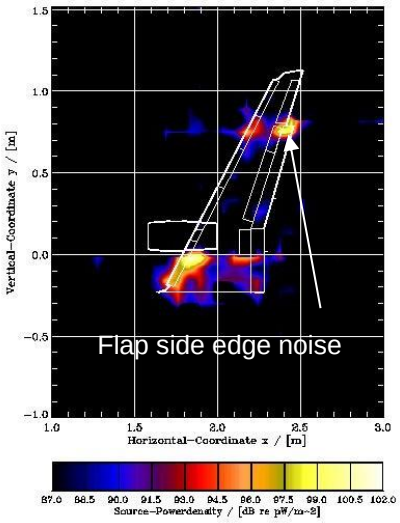
- Conclusion

Review



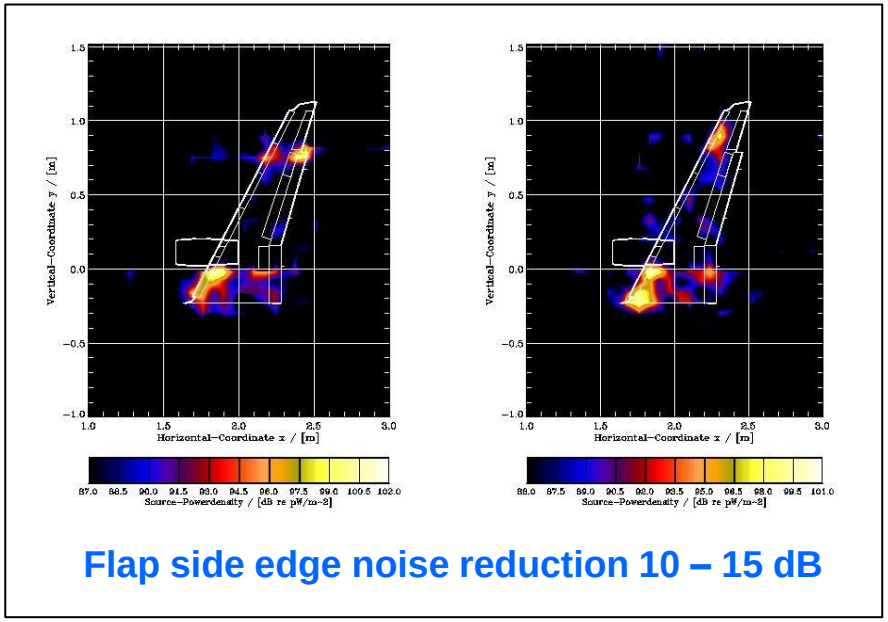
Source: Streett et al., NASA



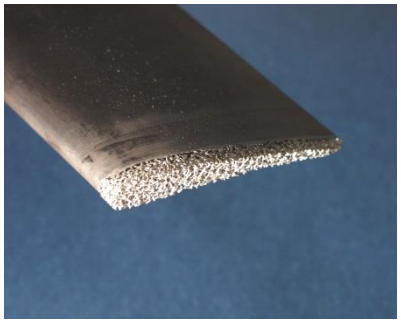
Aeroacoustic Wind Tunnel Cepra 19, 1:11 scaled 3D A320 wing

Review

Aerodynamically no impact

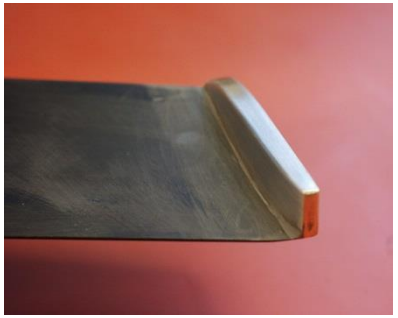


Flap side edge noise reduction 10 – 15 dB



Foam

Brushes



Rectangular Fence

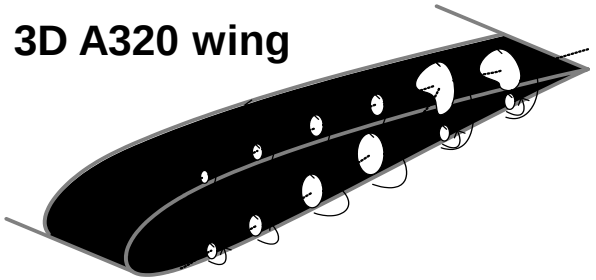
Elliptical Fence

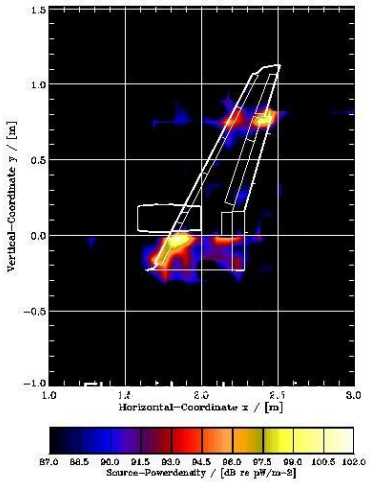
Motivation

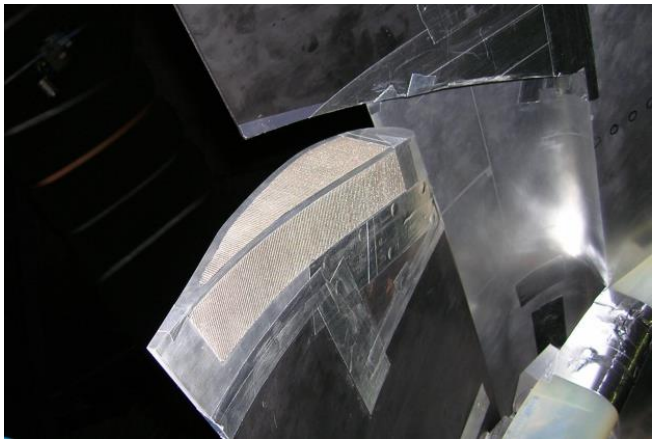
SWING, RAIN, SILENCER, FREQUENZ, OPENAIR

FSE Noise reduction studies on generic models (solid bodies)

3D A320 wing







Original A320 Flap

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Edges
Cavities
Roller (fish mouth)
Vortex Generator
Side Edge

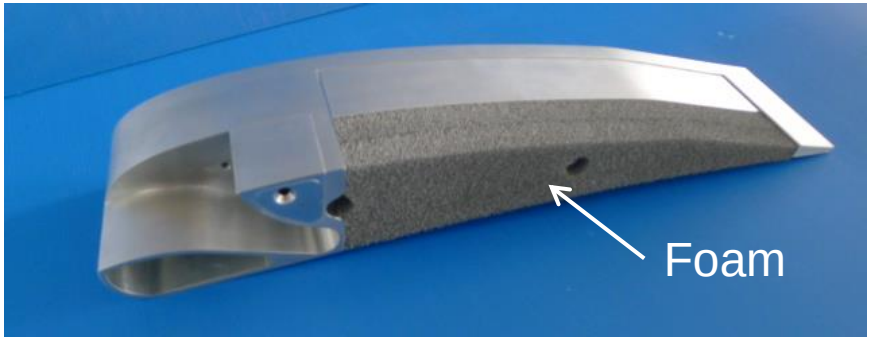
→ **Noise**

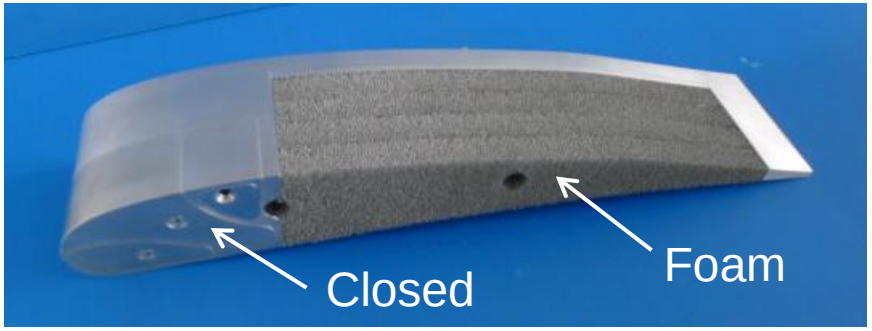
Open question: How do this mechanisms contribute to the overall noise level?

Objectives

- **Final acoustic check of porous FSE on a original A320 flap by wind tunnel tests**
- **Design, manufacture & integration of porous FSE for FT**
- **Flight Test**

FSE – Wind Tunnel Modell



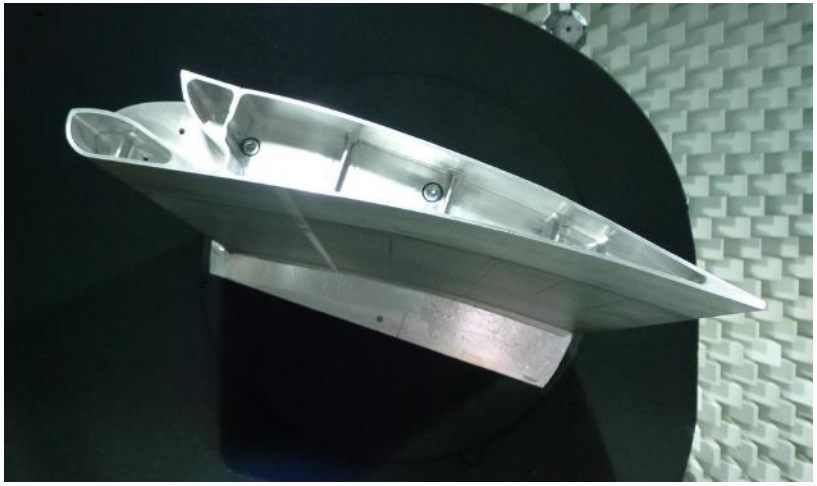


Effect of :

- **Foam**
- **Fish mouth**
- **Clean side edge**
- **Vortex generator**
- **Baseline**
- **Cavities**
- **Combinations**

11 Configurations

WTT



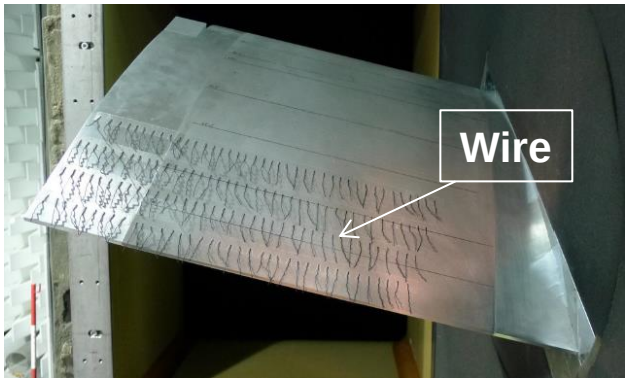
Aerodynamik Check on Baseline:

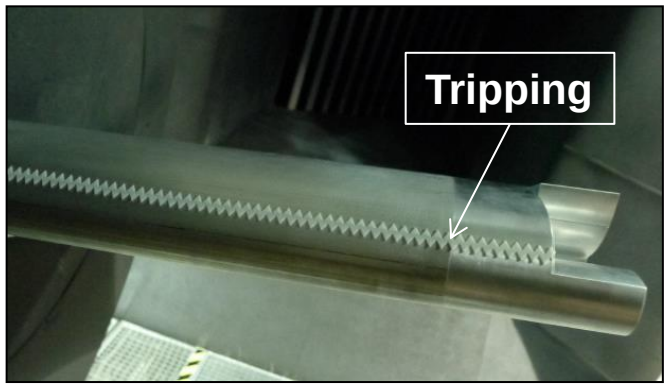
- Tripping on the pressure side and suction side of the flap to fix the transition point.

- Stick of wire on the rear range of the flap for flow visualisation.

- The check were carried out for v = 50 m/s and AOA = 30°, 25°, 20°, 15°

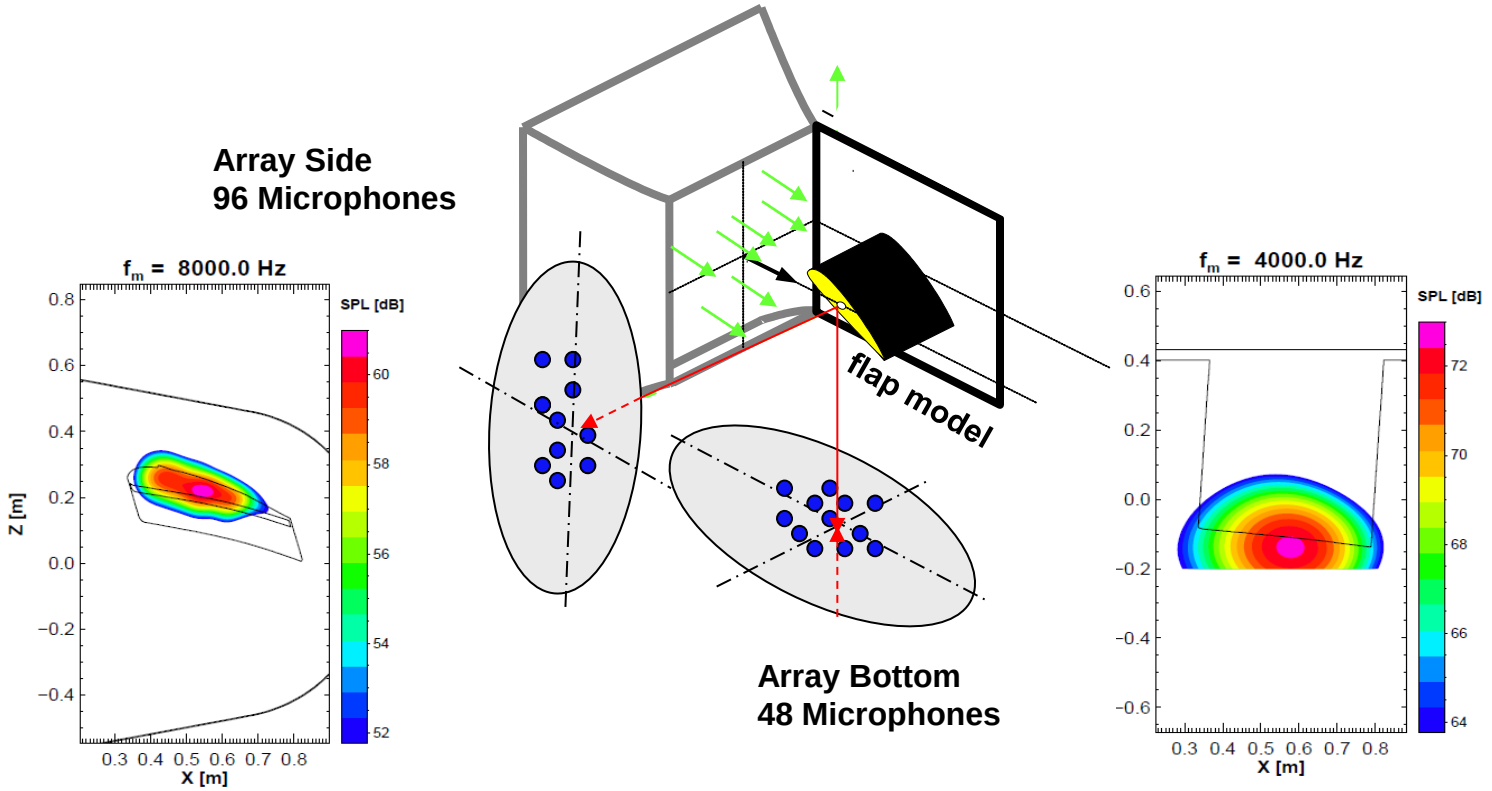
→ **Results:**
- AOA = 25° and >25° the flow is detached.
- AOA = 20° the flow in the range of the FSE is relativ killed.
- Operating conditions: 17°, 20°, 23°





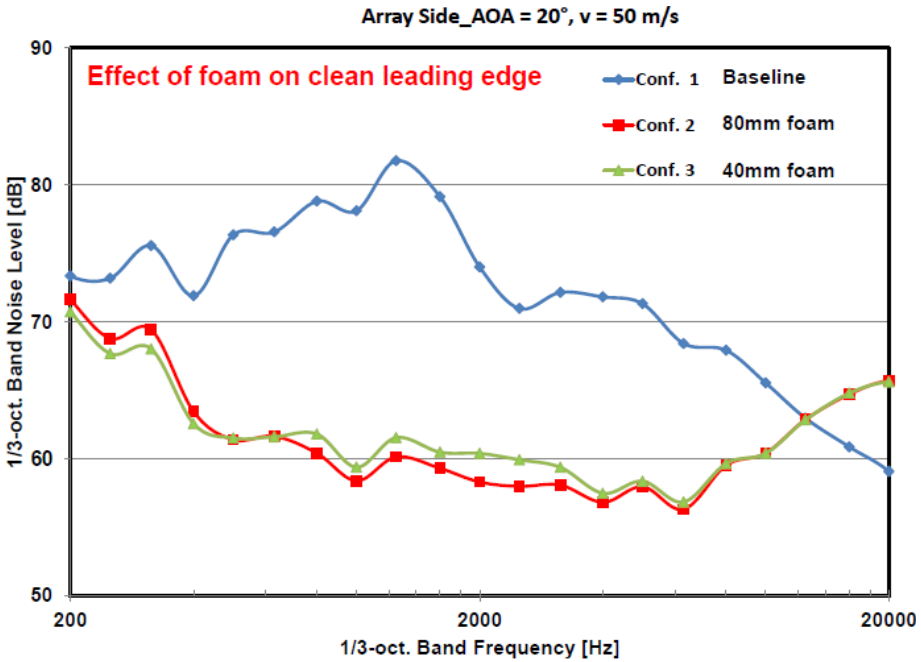
WTT

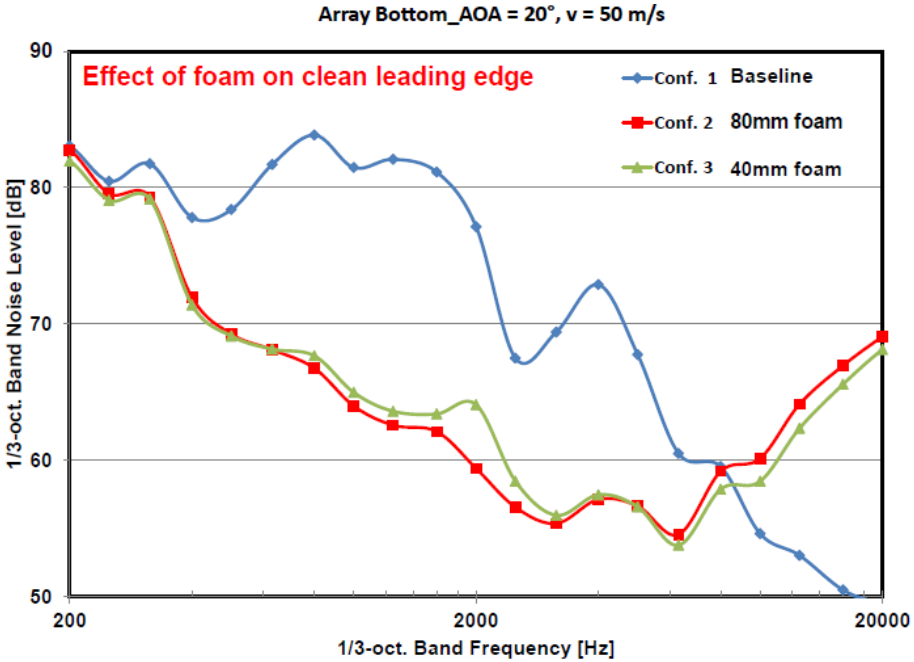
Side edge noise was localized and quantified by 2 microphone arrays:

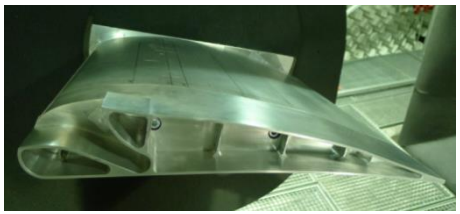


Integration of Source Power / 1/3-oct. Band → 1/3-oct. Spectra

Effect of foam on clean leading edge

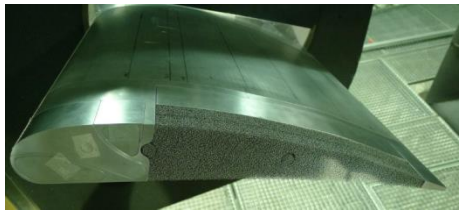






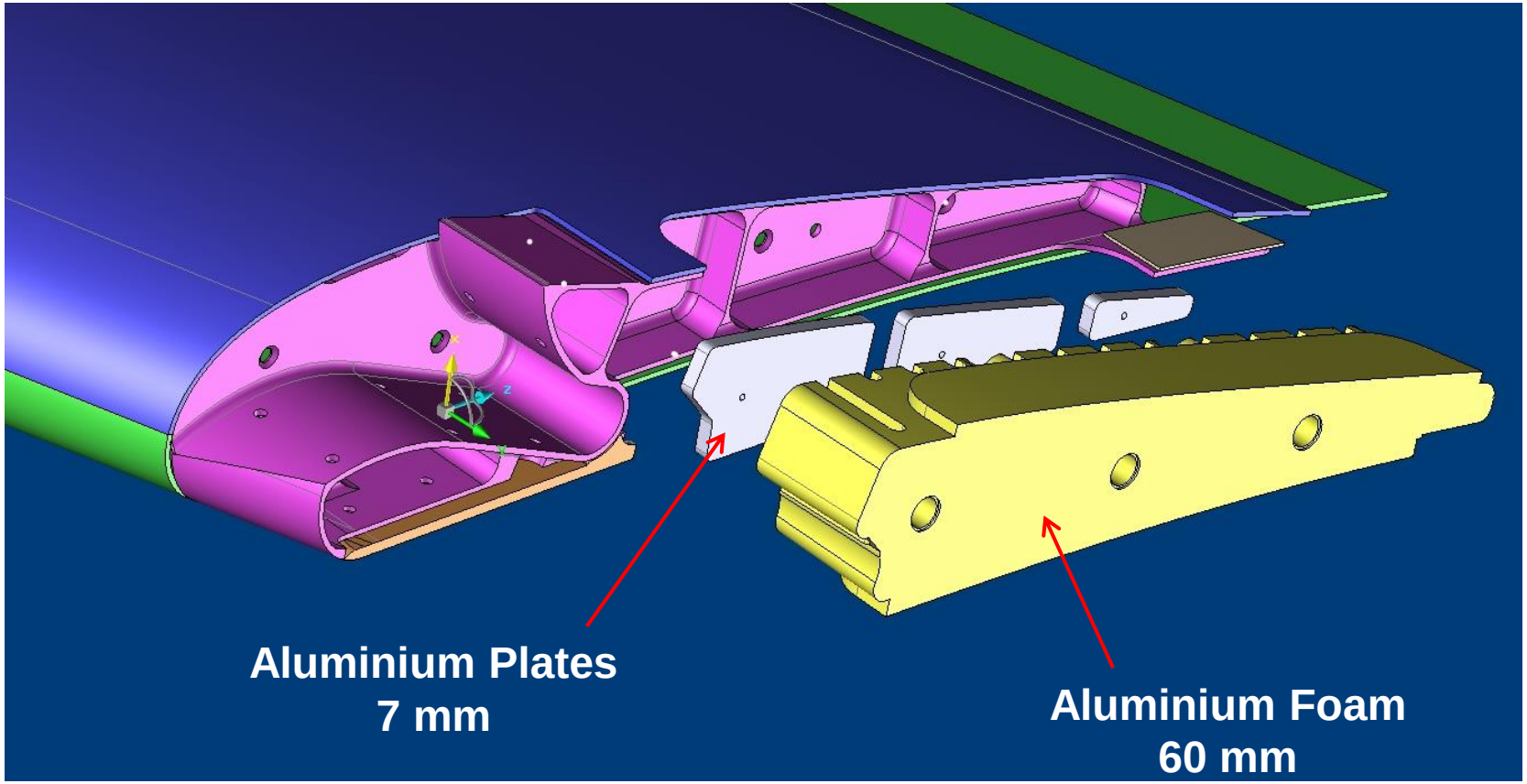
Conf. 1 Baseline

Conf. 2 80mm foam



Conf. 3 40mm foam

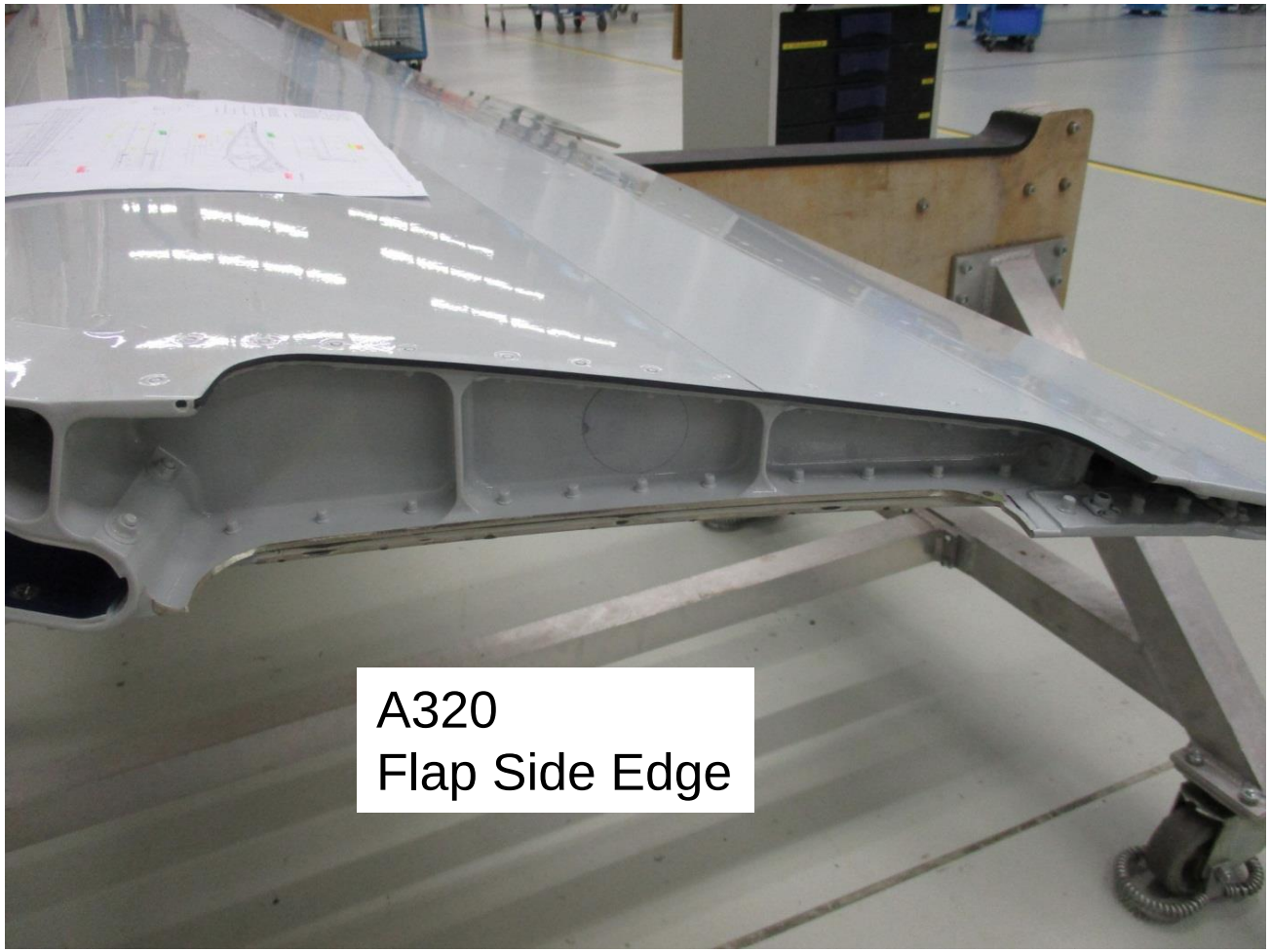
PFSE - Design



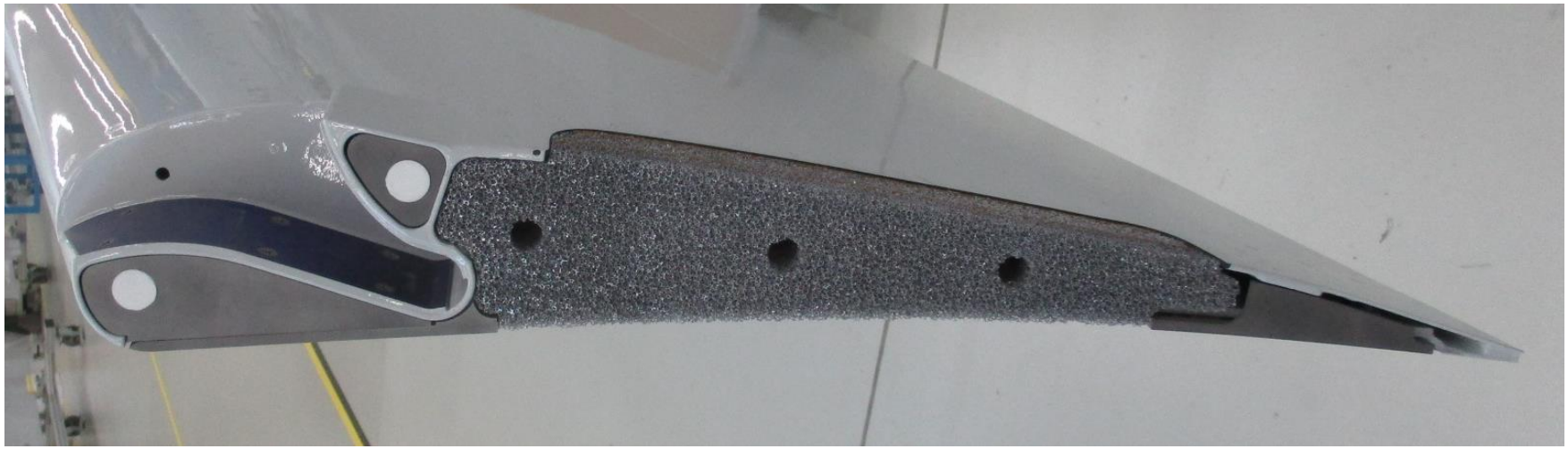
Manufacturing

Airworthiness Tests: static, dynamic, fatigue, temperature, icing

Integration



Integration



Flight Test

Flight Test

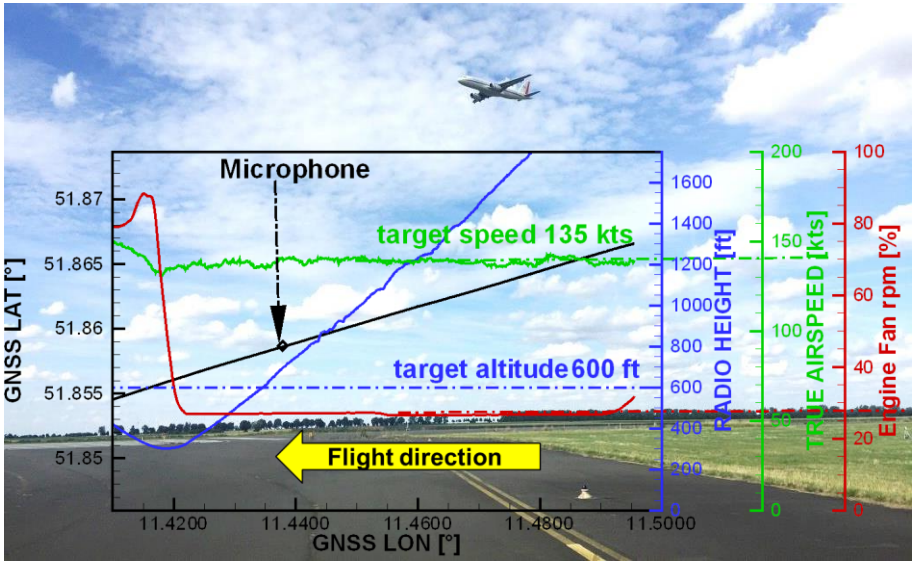
Aircraft Configuration and Flight Procedure

- A320-232 CEO with V2527 A5 engines and LIP
- Under wing vortex generators installed
- Flap set with outboard porous flap side edge
  - Conf A: **no** fish mouth filler
  - Conf B: **with** fish mouth filler

- Isolated assessment of PFSE effect on airframe noise
- Approaches at 135 and 170 kts
- Engines in flight idle mode
- Landing gear UP
- High lift systems
  Flaps 3: Slat 22°/ Flaps 20°
  Flaps FULL: Slat 27° / Flaps 40°

Conf. B

Fish mouth filled



Flight Test

Acoustic Metric and Results

Sound Exposure Level

$$SEL = 10 * log_{10} * \frac{1}{T_0} \int_{t_1}^{t_2} \left(\frac{P_A(t)}{P_0}\right)^2 dt$$

Correction for height and velocity (acc. to ICAO Annex 16)

$$\Delta L_H = 12.5 * log_{10}\left({}^{D}/_{D_{Ref}}\right) \text{ and}$$

$$\Delta L_V = 10.0 * log_{10}\left({}^{V}/_{V_{Ref}}\right)$$

additional correction for velocity dependent noise generation ($p'^2 \sim v^5$)

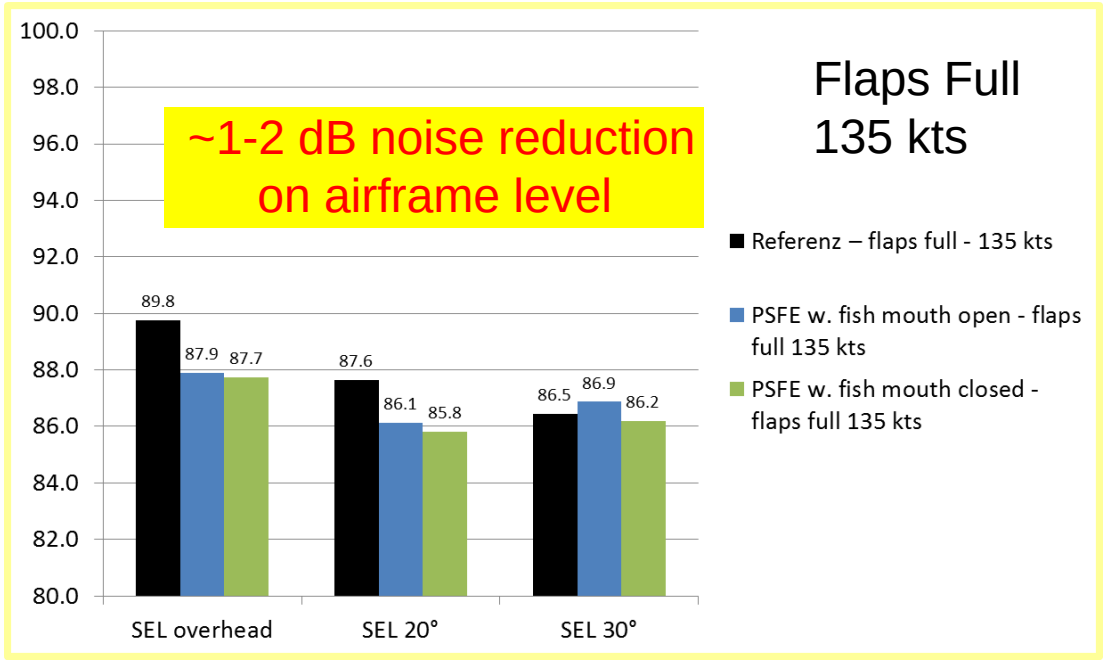
$$\Delta L = 50.0 * log_{10}\left({}^{V}/_{V_{Ref}}\right)$$

$$\boldsymbol{SEL_{korr} = L_{A,max} + \frac{t_{10}}{2}}$$

$$\boldsymbol{+12.5 * log_{10}\left({}^{D}/_{D_{Ref}}\right)}$$

$$\boldsymbol{-40.0 * log_{10}({}^{V}/_{V_{Ref}})}$$

Final SEL data is average over all valid flyovers



- **Significant noise reduction on airframe level of approx. -2 dB**
- **For higher speed slightly increased noise reduction**

Conclusion

Flight test results:

- 1-2 dB noise reduction on aircraft level

Next steps:

- long term test (fatigue) on a A320 (Lufthansa)
- retrofit

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